Motorcycle Helmets and Traumatic Brain Injury in Kentucky, 1995-2000

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BACKGROUND

In the six year period from 1995 to 2000, there were 5313 motorcycle crashes reported in Kentucky. There were 4916 injured and 185 motorcyclists killed as a result of these crashes (Kentucky Transportation Center 1995, 1996, 1997, 1998, 1999, 2000). Numerous studies across the United States have addressed the ability of motorcycle helmets to decrease morbidity and mortality associated with these events (Gabella, et al 1995; Kelly, et al 1991; Sarkar, et al 1995; Wagle, et al 1993). Until now, however, there have been no studies that analyzed Kentucky data in particular. This paper attempts to describe the relationship between motorcycle helmet use and traumatic brain injuries (TBI) in the state of Kentucky over the six year period from 1995 to 2000. The data included in this study are from the trauma registry of the University of Louisville Hospital, which is designated by the American College of Surgeons as a Level I Trauma Center. The University of Louisville trauma center serves a diverse population in urban, suburban, and rural areas of Kentucky.

DEFINITIONS

Subjects were included in this study if they were the driver of a motorcycle that was involved in a crash. Motorcycle crashes were identified using International Classification of Diseases, Ninth Revision (ICD-9) external cause of injury codes (E-codes) (World Health Organization 1977). The E-codes E810.0-E819.9 designate traffic accidents, and E-codes E820.0-E825.9 designate non-traffic accidents. The digit after the decimal identifies the subject as a motorcycle driver or a motorcycle passenger (drivers=2, passengers=3).

TBI is a category of injury defined by the Centers for Disease Control (CDC) using ICD9 nature of injury codes (N-codes), which include the following injuries (with their respective N-codes) (US Department of Health and Human Services 1995):

Fracture of the vault or base of the skull (800.0-801.9)
Other and unqualified and multiple fractures of the skull (803.0-804.9)

Intracranial injury, including concussion, contusion, laceration, and hemorrhage (850.0-854.1)

Head injury, unspecified (959.01)

These injuries are well known for their high case fatality rate and potential to produce lifelong disabilities.

METHODS

In preparation for this study, all years of trauma registry data were compiled into a single data set. A total of 339 motorcycle drivers were then identified by E-code. When choosing variables to include in the study, those that were best reported and potentially related to TBI or patterns of motorcycle riding were included. These include age (four categories: !~,20, 21-40, 41-60, 61+), gender (male=l, female=O), season of crash (January-March, April-June, July-September, October-December), traffic vs. non-traffic crash (traffic=l, non-traffic=O), night (8pm-5am) vs. day (5arn-8pm) (night=l, day--O), drug use (positive for illicit drugs=l, negative/not performed=0), race (white=l, black=O), and elevated blood alcohol concentration (BAC) (BAC greater than 0.08=1, below 0.08=0). Helmet usage (yes=l, no=O) was known for 311 of the 339 drivers (91.7%). Simple univariate analyses were performed to determine if there were factors likely to affect knowledge of helmet usage, and to determine which factors potentially affected TBI status. Finally, multiple logistic regressions were performed to further investigate the factors associated with motorcycle crashes and TBI. Analyses were performed using STATA statistical software (STATA Corporation 2000).

RESULTS

Analysis of age, gender, season, type of accident, time of accident, drug screen, BAC, and race revealed that males were more likely to have a known helmet usage status at the $p<0.05$ level (Table 1). No other factors were found to be distributed significantly different among those with known helmet usage and those with unknown helmet usage.

Table 1. Potential factors related to helmet usage status

FACTOR	VALUE	HELMET USAGE KNOWN (n=311)	Freq.	HELMET USAGE UNKNOWN (n=28)	Freq.	P-VALUE*
Age	0-20	26	0.08	2	0.07	0.60
	21-40	181	0.58	18	0.64	
	41-60	92	0.30	6	0.21	
	61+	12	0.04	2	0.07	
Gender	**Male**	**289**	**0.93**	**22**	**0.79**	**<0.01**
	Female	**22**	**0.07**	**6**	**0.21**	
Season	Jan-Mar	36	0.12	5	0.18	0.40
	Apr-Jun	103	0.33	12	0.43	
	Jul-Sep	131	0.42	8	0.29	
	Oct-Dec	41	0.13	3	0.11	
Type of Accident	Traffic	295	0.95	24	0.86	0.07
	Non-Traffic	16	0.05	4	0.14	
Time of Accident	8pm-5am	141	0.45	10	0.36	0.33
	5am-8pm	170	0.55	18	0.64	
Drug Screen	Positive	70	0.23	5	0.18	0.57
	Negative	241	0.77	23	0.82	
BAC	>0.08	72	0.23	4	0.14	0.35
	<0.08	239	0.77	24	0.86	
Race	White	288	0.93	24	0.86	0.20
	Black	23	0.07	4	0.14	

*X2 **statistic used for analysis, except where one or more cell sizes was <5, where Fisher's exact test was used.**

Univariate analysis performed on each potential risk factor to determine if any might affect the outcome (TBI or no TBI) of a motorcycle crash (Table 2) revealed that TBI was significantly more common in subjects who had an elevated BAC (X^2=10.75, p=0.001) and who were not wearing a helmet at the time of the crash (X^2 =29.96, p<0.001). No other potential risk factors were significantly different in those who sustained a TBI and those who did not sustain a TBI.

Table 2. Potential factors associated with outcome of TBI

RISK FACTOR	VALUE	TBI (n=125)	Freq.	No TBI (n=21 1)	Freq.	P-VALUE*
Age	0-20	15	0.12	13	0.06	0.08
	21-40	67	0.54	126	0.60	
	41-60	41	0.33	61	0.29	
	61+	2	0.02	11	0.05	
Gender	Male	112	0.90	181	0.86	0.40
	Female	13	0.10	30	0.14	
Season	Jan-Mar	15	0.12	24	0.11	0.89
	Apr-Jun	41	0.33	69	0.33	
	Jul-Sep	51	0.41	93	0.44	
	Oct-Dec	18	0.14	25	0.12	
Type Accident	Traffic	117	0.94	203	0.96	0.28
	Non-Traffic	8	0.06	8	0.04	
Time of Accident	Night (8pm-5am)	54	0.43	95	0.45	0.75
	Day (5am-8pm)	71	0.57	116	0.55	
Drug Screen	Positive	34	0.27	53	0.25	0.67
	Negative	91	0.73	158	0.75	
Race	Black	7	0.06	18	0.09	0.32
	White	118	0.94	193	0.91	
BAC	**>0.08**	**40**	**0.32**	**35**	**0.17**	**<0.01**
	<0.08	**85**	**0.68**	**176**	**0.83**	
Helmet Use	**Yes**	**39**	**0.31**	**131**	**0.62**	**<0.001**
	No	**86**	**0.69**	**80**	**0.38**	

*X2 statistic used for analysis, except where one or more cell sizes was <5, where Fisher's exact test was used.

Multiple logistic regression included all factors considered in the univariate analysis, regardless of whether they yielded significant results in that analysis. In the first regression, elevated BAC (0=0.86, p<0.01) and lack of helmet use (P=1.46, p<0.001) were again found to be the only significant factors relating to the outcome of TBI (Table 3). The odds ratios were 2.37 (95% C.I.=1.26-4.44) for elevated BAC, and 4.32 (95% C.I.=2.60-7.19) for lack of helmet use. There was no evidence for lack-of-fit (X^2=151.90, p=0.3 1) in this model. No other regressors were significant predictors of TBI.

Table 3. Results of logistic regression (n=31 1)*

REGRESSOR	COEFFICIENT	OR	95% OR CONF INTERVAL		Z-SCORE	P-VALUE
Age	-0.17	0.84	0.59	1.21	-0.92	0.36
Gender	0.55	1.74	0.67	4.52	1.13	0.26
Season	0.16	1.18	0.87	1.59	1.06	0.29
Traffic/Non-	-0.70	0.50	0.17	1.47	-1.26	0.21
Night/Day	-0.22	0.80	0.48	1.36	-0.82	0.41
Drugs	-0.14	0.87	0.48	1.57	-0.47	0.64
Race	0.15	1.16	0.41	3.27	0.28	0.78
BAC	**0.86**	**2.37**	**1.26**	**4.44**	**2.69**	**0.01**
No Helmet	**1.46**	**4.32**	**2.60**	**7.19**	**5.64**	**<0.01**

*Wald X^2=42.80
P<0.001

Since males were more likely to have a known helmet usage status, they were analyzed separately in another multiple logistic regression (Table 4). The results were very similar to those where both genders were analyzed together. This is to be expected since men so outnumbered women in the sample. It should be noted, however, that the odds ratios for both BAC and lack of helmet usage dropped when women were excluded from the regression. This suggests that women may be at even greater risk than men when they have a high BAC or do not wear a helmet. Unfortunately, the relatively small number of female drivers with known helmet usage status (n--22), prevented a similar analysis for women only.

Table 4. Results of males-only logistic regression (n=289)*

REGRESSOR	COEFFICIENT	OR	95% OR CONF	INTERVAL	Z-SCORE	P-VALUE
Age	-0.24	0.78	0.54	1.14	-1.286	0.20
Season	0.09	1.09	0.80	1.48	0.55	0.59
Traffic/Non-	-0.55	0.57	0.18	1.79	-0.96	0.34
Night/Day	-0.25	0.78	0.46	1.34	-0.89	0.37
Drugs	-0.10	0.90	0.49	1.67	-0.32	0.75
Race	0.16	1.17	0.41	3.33	0.30	0.77
BAC	**0.74**	**2.10**	**1.10**	**4.00**	**2.26**	**0.02**
No Helmet	**1.44**	**4.24**	**2.52**	**7.12**	**5.45**	**<0.001**

*Wald X^2 =37.98
P<0.0001

DISCUSSION

The findings of this study are consistent with similar studies performed in recent years in other states (Gabella, et al 1995; Wagle, et al 1993). However, there are some limitations in this study. Foremost among these is the lack of data from police reports. Police crash reports can supply information on speed limits, other vehicles involved in the crash, weather conditions, road conditions, and other factors potentially related to the cause of the crash. The R2 for this model is 0. 11, revealing that there is still much variation to explain. Presumably, inclusion of crash data such as those mentioned above would be very helpful in "filling out" the model presented here. Indeed, Gabella, et al. (1995) reported on a logistic regression where they found only lack of helmet use, DUI citation, and extreme motorcycle damage to be significant predictors of TBI in Colorado motorcyclists. They reported a smaller effect for lack of helmet use (OR=2.41), and this is likely due to their inclusion of a measure of crash severity (extreme motorcycle damage, OR=2.13). Their odds ratio estimate for DUI citation (OR=2.85) was similar to the elevated BAC odds ratio reported here.

The differing rates of helmet usage status reporting for men and women are of great concern for future analyses. Why female motorcycle drivers are less likely to have a known helmet usage is certainly an interesting question, and one that may also be investigated through analysis of police crash report data. Since there are many fewer female motorcyclists, it is already difficult to study this population. The lack of data in this case makes it even more problematic.

Despite the minor flaws discussed here, there can be little doubt that these results support the conclusion of numerous other studies nationwide: lack of helmet usage is one of the most powerful factors, even more powerful than alcohol intoxication, in predicting who sustains a TBI in motorcycle crashes.

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